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Cruise Report

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STRUCTURE, FUNCTION, AND BIOLOGICAL/PHYSICAL COUPLING OF DEEP REEF COMMUNITIES IN THE NORTHEASTERN GULF OF MEXICO

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Integrated Oceanographic Study of the Northeastern Gulf of Mexico (IOS-NEGOM)

Kenneth J. Sulak, George D. Dennis III and James V. Gardner

U.S. Department of the Interior
U.S. Geological Survey
Biological Resources Division
Minerals Management Service

MMS U.S. Department of the Interior
Minerals Management Service
Gulf of Mexico OCS Region

Integrated Oceanographic Study of the Northeastern Gulf of Mexico (IOS-NEGOM)

USGS Component:

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Cruise: TM-2003-01
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Prepared by:

R. Allen Brooks, Andrew J. Quaid and Kenneth J. Sulak (Principal Investigator)

USGS Florida Integrated Science Center, 7920 NW 71st St., Gainesville, FL, 32953, 352-378-8181

Co-Principal Investigators:

George Dennis III, U.S. Fish and Wildlife Service, Ecological Services Office, Vero Beach, FL

James V. Gardner, Center for Coastal & Ocean Mapping, University of New Hampshire, Durham, NH *new address

Collaborators:

John Caruso, University of New Orleans, New Orleans, LA

Joanne Lyczkowski-Shultz, National Marine Fisheries Service, Pascagoula, MS

Richard McBride, Florida Marine Research Institute, St. Petersburg, FL

Martha Nizinski, NOAA/NMFS Systematics Laboratory, Smithsonian Institution, Washington D.C.

Steve W. Ross, University of North Carolina – Wilmington, Wilmington, NC

Cover page illustration: Digital image of the planktivorous, OCS deep-reef dwelling soft coral, *Nicella* obtained with the ROV Scorpio underwater digital camera (Station No. TM 2003-01-005, Depth 58 m)

*** Dr. James V. Gardner**
Center for Coastal & Ocean Mapping
24 Colovos Road
University of New Hampshire
Durham, NH 03824
Phone 603-862-3473

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INTRODUCTION

The Minerals Management Service (MMS) advanced a 4-year plan of integrated physical/biological research to be conducted in northeastern Gulf of Mexico beginning in 2001: "Integrated Oceanographic Study of the Northeastern Gulf of Mexico (IOS-NEGOM)" (Sulak et. al., 2001). This plan, outlined in the "MMS GOM Region Planning Document" (MMS, 2000a) and its companion document "Elements of Interagency Agreement (EIA) between MMS & USGS" (Boland, 2000) define the principal questions to be addressed and the information needs for the IOS-NEGOM study. The overall IOS-NEGOM study area (Figure 1) encompasses a 52 x 1000 km^2 sector of the central and eastern NEGOM region (Longitude 84.34^o to 88.75^o W, 10 m to 500 m isobaths) (MMS, 2000b). The USGS, as part of continuing long term policy to help address MMS information needs in the region, undertook research to address those topics that provide an integrated basis of understanding of structure and function of key biological communities and critical habitats in relation to physical processes. USGS scientists from the Coastal Ecology and Conservation Research Group, Florida Integrated Science Center, Gainesville, Florida have identified acquisition of fundamental knowledge on fish and megafaunal invertebrate community structure and function as a primary long-term study goal. The guiding interagency principal question is: "What are the potential [biological] impacts from oil and gas activities" (EIA) and in particular on live-bottom and hard-bottom biotopes?." The USGS study plan responds to MMS OCS information needs and will provide direct input to management decisions that impact the regulation of offshore oil and gas operations. The present cruise report summarizes the final IOS-NEGOM biological field mission undertaken by the USGS CEC Research Group.

BACKGROUND

The outer continental shelf of the northeastern Gulf of Mexico (NEGOM) is populated with a large number of hard-bottom topographical features (Gardner et al., 2000; Gardner et al., 2001a). Parker et al. (1983) estimated that there was substantially more hard bottom habitat in this area compared to that in the northwestern Gulf of Mexico and along the Atlantic coast. The eastern part of the NEGOM region is separated from the western part, by the DeSoto Canyon (Figure 1), which forms a physical and hydrographic barrier separating shelf and slope faunas (Shipp and Hopkins, 1978). The region's hard-bottom habitats were first characterized by Ludwick and Walton (1957) from an intensive single-beam echo sounding survey revealing an extensive area of "pinnacles" in the western NEGOM region. Recently, the USGS used a Kongsberg Simrad EM 1002 Multibeam Mapping System to produce high resolution maps of the northwestern Florida shelf and Mississippi-Alabama shelf/slope (Gardner et al., 2002). Mapping resulted in 4 m resolution subarea maps (Gardner et al., 2000; Gardner et al., 2001b) identifying individual rock formations. Additionally, co-registered acoustic backscatter maps were generated (Gardner et al., 2001a). The work of Gardner et al. (2001a) describes many of the reef pinnacles and hardgrounds on the Mississippi-Alabama shelf. These structures consistently have a sand build-up on to the north and an eroded moat to the south caused by the Loop current. Other structures found on this part of the shelf include a prominent ridge, a salt dome, and several large landslide scars with resultant slumps (Gardner et al., 2001a).

Our focus on reef-like topographic features is due to the sensitivity of hard bottom

communities to disturbance (Rezak et al., 1990) and their significance as both trophic and spawning habitat (Coleman et al. 1996; Koenig et al., 2000). Topographical features affect water circulation along the shelf edge (Moum and Nash, 2000) and may have significant effects on ocean mixing (Lueck and Mudge, 1997). They may also exert dominant biological influence through topographic-hydrographic interaction (Hamner et al., 1988; Witman et al., 1993). Near-reef current measurements in the western NEGOM suggest topographically induced turbulence exists (Kelly et al., 2000). Increased turbulence may enhance availability of plankton to planktivores through current compression over topographic features (Genin et al., 1986) and potentially increase production over broad areas of heterogeneous relief, such as the Pinnacles (Weaver et al., 2002). Changes in near-bottom flow may also control local small-scale epifaunal and fish distributions (Genin et al., 1986; Messing et al., 1990; MacDonald et al., 1996). These observations suggest that the biological community is tightly coupled to physical structure (topography) and resultant hydrographic processes (turbulent fields), related to the interaction of physical structure and currents. The present research seeks to further define the basis of physical-biological coupling, and aspects of community structure and function (e.g., species dominance, trophodynamics, population age structure, reproductive cycles, and recruitment), biotope affinities, and critical habitat parameters on these topographical features as many are well known fishing areas (Moe, 1963) considered essential fish habitat by NOAA Fisheries.

OBJECTIVES

Our USGS team established a study plan with five main objectives (Sulak et al. 2001). The objectives are outlined below and were developed to exploit the capabilities, expertise, and existing strategic OCS research direction of USGS.

1) Map the study area using a high-resolution multibeam mapping system (HRMBS). HRMBS mapping will be used to identify areas of hard bottom and to resolve the zone of reef influence on nearby soft bottom habitat. The total areal extent of the reef biotope is much greater than the physical reef structures themselves, due to the halo of reef-dependent, reef-influenced communities surrounding and extending well away from reefs. This heterogeneous habitat (reef plus halo biotopes) is apparent in acoustic reflectivity surveys (Gardner et al., 2000), in the form of high reflectivity substrate surfaces (reef rubble, and current-swept and biologically reworked sediment) adjacent to hard-bottom areas. Mapping will serve both to accurately locate target study reefs, and to define overall topography including the locations of all hard-bottom features. Precise mapping of topographical features will allow more detailed and coordinated studies of processes on individual features on a scale relevant to the biotic community. High-resolution bathymetry is now available for the eastern NEGOM Pinnacles area (Gardner et al., 2000) and the western area will be mapped in 2001. From the HRMBS mapping the area of each biotope type will be calculated and resulting bathymetry, shaded relief, and backscatter products will be prepared as Arcview project files for use by other researchers (especially our collaborators and cooperators).

2) Determine the community structure of fish and epifaunal assemblages, on hard bottm, in the eastern NEGOM area. The composition and abundance of the fish assemblage,

focusing on non-resource species that comprise the forage base, will be resolved and compared to previous work in the western NEGOM. Inner (60-80 m) and outer (100-120 m) shelf-edge features will be compared and related to other deep reef habitats in the Gulf of Mexico and Caribbean. Megafauna and encrusting epifauna assemblages will be compared between the eastern and western NEGOM.

Data developed from community structure analyses will be used to test specific hypotheses regarding potentially different NEGOM communities on either side of De Soto Canyon. Important questions to be phrased as hypotheses would include: Do eastern OCS reef fish communities serve as distributional stepping stones for the translocation of species west of De Soto Canyon? Is the winnowing of species composition a gradual latitudinal, temperature-related phenomenon, or does faunal transition take place more abruptly across large-scale physical discontinuities (e.g., De Soto Canyon), and across local-scale biotope boundaries. Also we expect to develop a model to predict hard bottom diversity from geologic and oceanographic parameters.

3) Determine the energy sources of driving the system and define the trophic linkage among dominant fish and megafaunal invertebrate taxa. A second major USGS research question for the IOS-NEGOM study, is what are the sources of nutrients driving the ecosystem. Addressing this question will entail definition of trophic linkages and trophodynamics of dominant fish and megafaunal invertebrate communities inhabiting critical heterogeneous biotopes — in relation to energy sources (water column and benthic) and physical processes (topography, currents). Research in this regard will extend from ongoing USGS food habit and food web studies in the NEGOM-CMEP (western IOS-NEGOM) (Sulak and Weaver, 2001) and will coordinate with data collected from proposed IOS-NEGOM oceanography sampling and existing historical energy source data. Analyses for the current project would consist of carbon and nitrogen (and possibly sulfur) stable isotope tissue analyses to determine the sources of energy input, to define horizontal (inshore versus deep-water; off-reef versus on-reef) and vertical trophic linkages, and to specify the trophic levels occupied by microvore and megavore predators.

4) Determine life history aspects of dominant forage base species. There is little information on these ecologically key taxa. Productivity (turnover rate) and resilience to disturbance are functions of longevity and reproductive mode. Important life history parameters such as, age, growth rate, and sexual pattern, will be determined to assess the sensitivity to disturbance of this faunal component.

5) Determine what fish spawn and recruit to the IOS-NEGOM area. The SEAMAP ichthyoplankton database will be synthesized with special regard to reef fish species. The regional composition of ichthyoplankton will be summarized and placed in context with knowledge of Gulf-wide patterns.

The objective of the TM-2003-01 cruise was the completion of investigations on community structure including:

1) ROV video and digital still documentation and quantification of fish and invertebrate community structure.

2) Completion of stable isotope collection from a target number of thirty individuals from each taxonomic or ontogenetic entity.

3) Completion of ROV video exploration and faunal inventory of NEGOM-West comparative reef and habitat types.

METHODS

Scientific Crew

1) Kenneth Sulak, USGS, CEC Group, Chief Scientist
2) Allen Brooks, USGS, CEC Group, Benthos and Isotope Operations Chief
3) Martha Nizinski, NOAA/NMFS, Invertebrate Taxonomist
4) Micheal Randall, USGS, CEC Group, Trawl Master
5) James Berg, USGS, CEC Group Angling Operations Chief
6) Andrew Quaid, USGS, CEC Group, Data Curator & Mapping/Navigation Coordinator
7) George Yeargin, USGS, CEC Group, Rigging Master & Safety Officer
8) Lance Horn, NURC/UNCW, ROV Operator
9) William Harden, USGS, CEC Group, ROV Assistant
10) Buck Albert, USGS, Layout Photographer
11) Clifford Bennett, Private, Specimen Preparation and Layout Photographer

General Operations Schedule

Two crews worked alternating six hour shifts. The first shift was from 1200-1800 & 2400-0600. The shift's responsibilities were based around ROV operations and Ken Sulak was the watch chief. First shift personnel included Horn, Quaid, Nizinski, Brooks, and Harden. The second shift was from 0600-1200 & 1800-2000. The shift's responsibilities involved sampling via surface-deployed gear. Michael Randall was the watch chief and the shift personnel were Yeargin, Berg, Bennett, and Albert.

Study Area

The 2003 mission study area is on the western side of the NEGOM area (Figure 1). Six specific sampling sites were chosen based upon the bathymetric data from our previous work (Gardner et al., 2000, Gardner et al. 2001b, Gardner et al. 2002): Mountain Top, Alabama Alps, Double Top and Pancake Reefs, Ludwick & Walton Pinnacles, Foreslope Talus Blocks, and Roughtongue Reef (Figure 2).

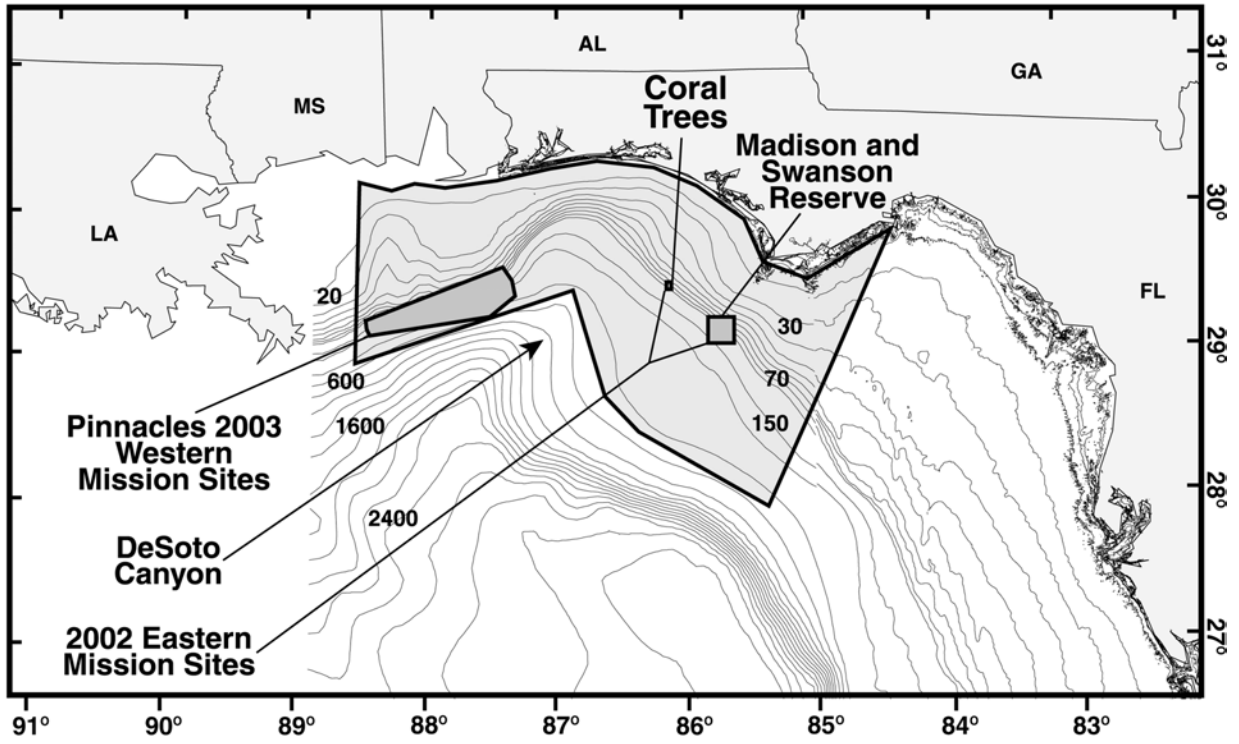

Figure 1. The NEGOM study area (Polygon) with 2003 western and comparative 2002 mission sites indicated. (isobaths are in meters)

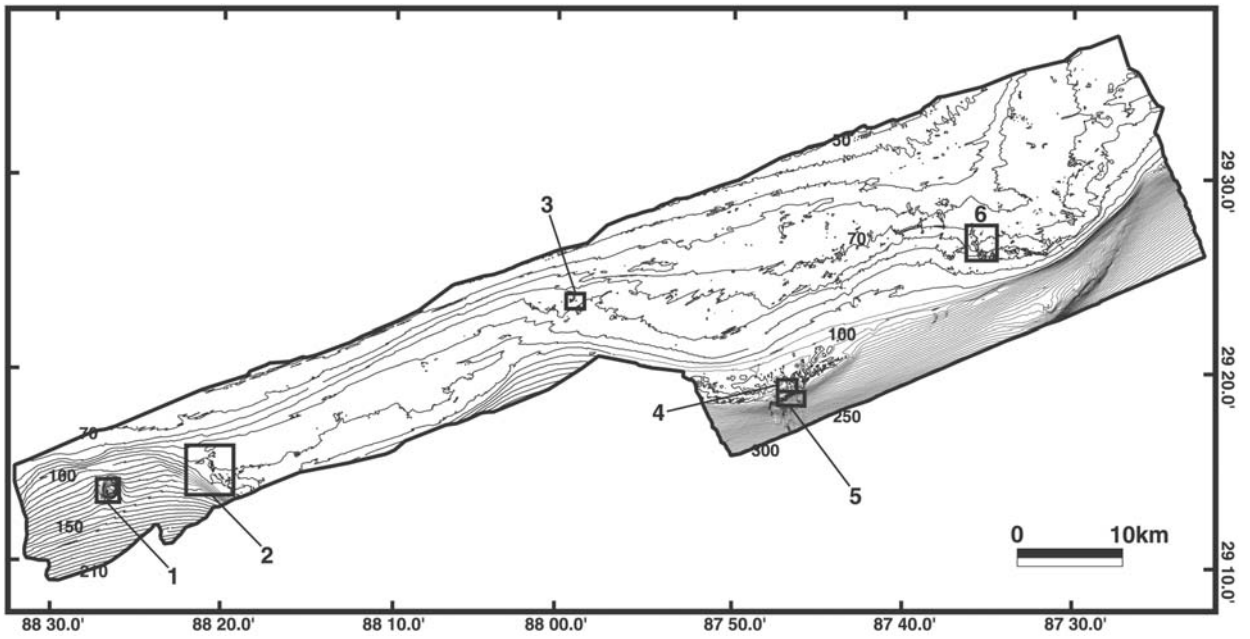

Figure 2. TM-2003-01 cruise study sites: 1) Mountain Top, 2) Alabama Alps, 3) Double Top and Pancake Reefs, 4) Ludwick & Walton Pinnacles, 5) Foreslope Talus Blocks, and 6) Roughtongue Reef.* (isobaths are in meters)

*Reef names are USGS/CEC study site names of convenience. They are not official geographic place names.

Sampling Platform

The R/V "Tommy Munro", a 29.5 m research vessel from the Gulf Coast Research Laboratory, Ocean Springs, Mississippi, was used as the sampling platform for this cruise (Figure 3). The "Tommy Munro" has the capability to anchor in 60-200 m of water, providing a platform for research operations over a specific sampling point. The Tommy Munro is also capable of conducting continuous 24-hours per day, seven days per week, operations on the outer continental shelf, in conditions up to 2-3 m seas, with a sea keeping limit (fuel, water, food) of seven days. Additionally, the ship is fitted with a boom arm to which a hydrophone to receive that intercepts transmissions from the underwater Trackpoint system. When used in conjunction with Hypak Max navigational software, the system allows for GPS positioning of the Remotely Operated Vehicle (ROV) used in this study.

Figure 3. The R/V "Tommy Munro" from the Gulf Coast Research Laboratory.

Remotely Operated Vehicle

The NOAA National Undersea Research Center/University of North Carolina-Wilmington (NURC/UNCW) Phantom S2 ROV (Figure 4) has high quality video and digital still imaging capabilities and was used to estimate the distribution and abundance of megafaunal fish and invertebrates at each study site. High-resolution multibeam coverage of the area, provided by previous work, (Gardner et al., 2000; Gardner et al. 2001b; Gardner et al 2002), was loaded into Hypak Max software as geo-referenced tagged image files (or .tiff images). The use of Hypak Max, coupled with the ROV's Trackpoint system, allowed us to determine the location of the ROV on the reef, at all times. Analysis of times when the ROV is stationary on the bottom for over 30 seconds indicate a standard deviation of $\pm$ 4.7 m (x) and $\pm$ 0.3 m (y) error in positioning.

Transects - On each ROV dive (with acceptable visibility and current velocities), twelve 2-minute video transects were made. Each transect consisted of digital-video taping of the bottom

at a constant camera angle, speed, and altitude for two minutes. A different random bearing, from a starting position behind the research vessel, was used to determine the heading for each replicate transect.

Still Images (Percent Cover) – The ROV was equipped with a Scorpio Digital Still Camera, from Insite Pacific Incorporated. The Digital Scorpio is designed for remote camera operation on the surface and allows for up to 300 pictures to be taken on a single dive. The images are formatted as "jpegs" and one megabyte in size, (2048 X 1536 pixels). Digital still images were taken to determine epifaunal cover (including algal and sponge cover) at each site (n=30 images). For each percent cover shot, the ROV operator was given a random bearing to follow for a random length of time (1-60 s), at which point the ROV was positioned above the bottom and a downward-looking, digital photograph was taken. The lasers on the ROV were used to ensure that the ROV was consistently at the same height above the bottom for each picture. Due to mechanical failure, digital still images were only taken on ROV dives conducted at the Mountain Top site due to mechanical failure.

Still Images (Species Documentation) - Digital still images were taken of selected fish and invertebrate taxa. Images will be used to aid specimen identification, record habitat use/association, and document inter/intra species relationships.

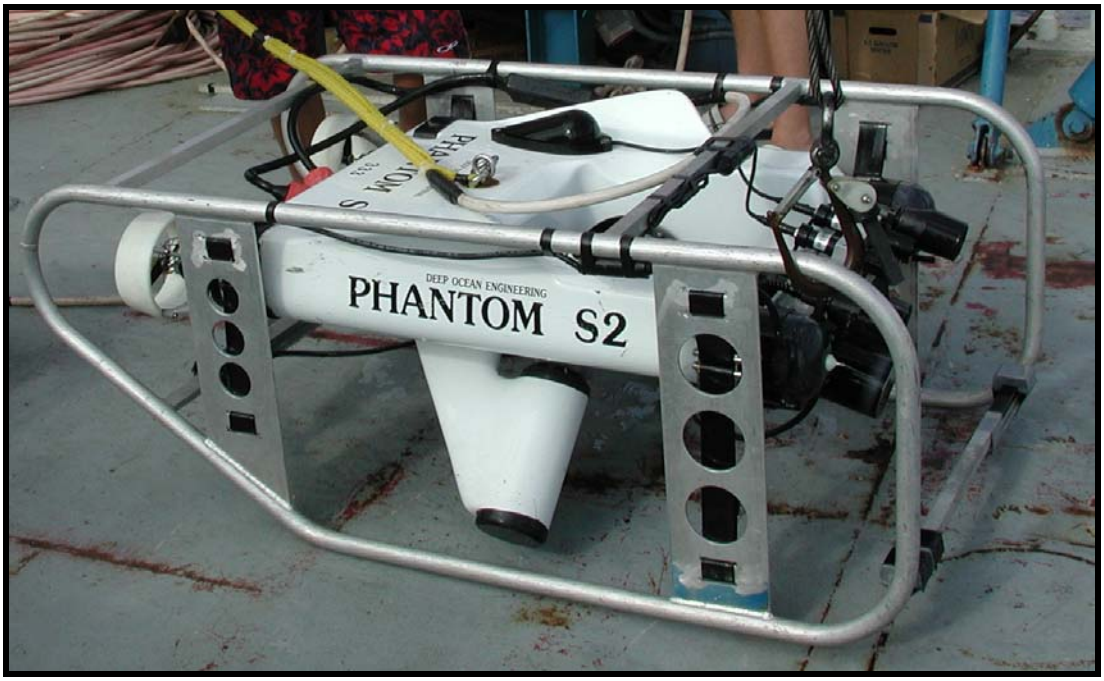

Figure 4. The NOAA National Undersea Research Center/ University of North Carolina Wilmington (NURC/UNCW) Phantom S2 ROV.

ROV Data Analysis

Video Tape Analysis – All fish observed during the 2-minute transects will be tabulated and identified (to species when possible). Sessile epifauna greater than 2 cm in height (e.g., gorgonians, sponges, black corals, crinoids) and intercepted by the bottom of the video frame during each transect will also be tabulated. Epifauna will be identified to lowest possible taxa, and grouped into functional categories (i.e., see fans, branching corals). Additionally, the presence/absence of encrusting algae, cup coral colonies, and discarded longline was scored on 15 second intervals during each transect. Navigational logging of the ROV position with the Hypak Max system will be used to determine the approximate length of each transect. Average density (individuals/m^2), of both fish and epifauna, will be determined.

Still Photo Analysis – Epifaunal percent cover will be determined from the digital still photographs. Using the Point Count Program originally developed for the Florida Keys Coral Reef Monitoring Program, random points are overlaid on top of each photograph and the taxa that are intercepted by a point recorded. Percent cover is subsequently determined. Analysis of images collected during the TM-2002-01 cruise indicated no significant difference between the percent cover estimates derived using twenty versus forty, sixty, eighty, or one hundred random points (Paired T-test, $P>0.05$). Therefore, twenty points were used for all analyses.

Fish/Invertebrate Collection

A variety of gear types were utilized for both fish and invertebrate sampling, and each gear type is described below. Using such a variety of sampling methods allowed us to collect a wide diversity of specimens, from multiple habitat types. Species identification, and length measurement (standard, fork, or total) was taken for all fish specimens collected.

Angling - Small, planktivorous reef-dwelling fishes were captured using "Sabiki" rigs comprised of six small hooks (sizes 3, 4, 6, 8) with scale feathers and red or glow-in-the-dark heads on a light main line. This rig mimics zooplankton that is the primary food source for planktivorous reef fishes. Larger higher-trophic-level species were collected using small to medium hooks with cut bait, either squid, bait fish, or fresh caught fishes.

Trawl - A 4.9 m, small mesh otter trawl (3.8 cm throat and bag mesh, and 0.6 cm cod mesh) was deployed to sample near-reef and away-from reef benthic fauna (Figure 5). Trawl tows were made during both daytime and nighttime hours.

Longline – A 15 meter length of heavy fishing line, with six snoods attached, was deployed to the bottom to sample benthic reef fish. The line was baited with either frozen or fresh-cut bait.

Tangles – A multi-stranded rope bundle, which consisted of many pieces of line which were frayed on the ends, was lowered to the bottom for invertebrate collection. The frayed ends are highly effective at entrapping gorgonians and crustaceans (with hard pointed carapaces).

Figure 5. Deployment of the 4.9 m otter trawl to sample hard-bottom associated fish and invertebrates, from off-reef biotopes.

Sled - A 1 m wide by 30 cm high modified Woods Hole epibenthic sled (0.125 cm mesh) was deployed to collect small benthic fishes and epifaunal invertebrates (Figure 6). The sled was modified to protect its lining from being torn on submerged obstacles, by adding a poly-vinyl chaff guard.

Figure 6. Deployment of the benthic sled to sample benthic fish and invertebrates.

Traps – Fish traps, both a chevron (1.8 m X 1.5 m X 0.6 m, with 25 mm X 12 mm mesh), and a box type (1.2 m X 1.2 m X 0.6 m, with 25 mm hexagonal wire) were deployed on reef habitat to sample fish and invertebrate species (Figure 7). Dissolvable fittings were utilized to allow for escapement of fauna, if the trap was lost. All of the traps were baited using either squid or fish and were either chevron or square shaped. The traps were deployed in three strings of four traps (n=12).

Figure 7. Fish trap recovery after several days of deployment.

Stable Isotope Collection

Fish tissue, invertebrate, phytoplankton, zooplankton, and sediment samples were taken for stable isotope analysis (nitrogen and carbon). A target number of 30 specimens per taxon, was established. Approximately 5 g of tissue from each sample was preserved by freezing in 2 ml glass vials. Phytoplankton and zooplankton were sampled using a double 0.5 m diameter ring net consisting of a 335 µm mesh net sewn inside of a 125 µm mesh net. Plankton tows were made near the surface (3 m) and then just above bottom (<3 m). Sediment samples were taken using a modified box grab. Approximately, 500 cc of sediment was taken and preserved by freezing for future analysis.

Water Chemistry and Light Data

A Seabird (Model SBE 19+) conductivity, temperature, and depth instrument (CTD) was used to record water parameters (Figure 8). A StowAway LI light meter produced by Onset Computer Corporation was also installed on the Seabird cage, to collect light intensity data during each daytime cast. The cast data contains the following parameters; temperature (0.000 ^{o}C), conductivity (0.00000 S/m), depth (0.00 m), oxygen concentration (0.0000 mg/L), oxygen saturation (0.000 %), density (0.000 kg/m^3) salinity (0.000 PSU), light levels (log lumens/ meter^2), and elapsed time. Data manipulation was handled in a series of steps. The first three steps (conversion from hexadecimal to text format, derivation of density, salinity, and then depth-bin averaging of data) were processed using the SBE-data processing program, provided by Sea-Bird Electronics Incorporated. The fourth step was to import the text file (of all converted and derived data) into a Microsoft Excel spreadsheet. The fifth and sixth steps (performed if light data was collected), were to import the light meter data into Excel, and then use the elapsed time to join the data.

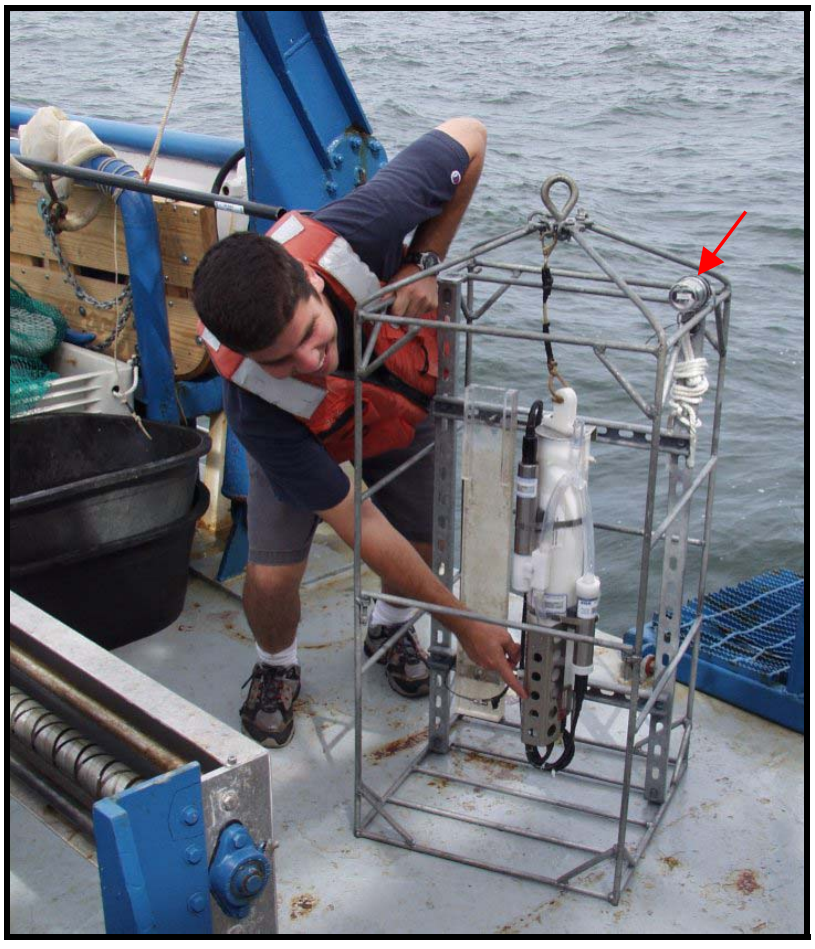

Figure 8. Seabird CTD array ready to deploy. Note light meter (arrow) attached to the top of the cage.

RESULTS

Sampling Stations

One hundred and ten sampling stations were occupied (Figures 9-14). Station data is presented in Appendix A, for each sampling site. The Mountain Top site was visited on 11 June 2003, and 25 stations were sampled over a 23 hour period, using 11 different sampling techniques (Figure 9). The Alabama Alps site was visited on 12 June and 16 June 2003, and 22 stations were sampled during a 20 hour period, using 11 different sampling techniques (Figure 10). The Double Top and Pancake Reefs were visited on 16 June 2003, and 10 stations were sampled over a 20 hour period, using 6 different sampling techniques (Figure 11). The Ludwick and Walton Pinnacles were visited on 14 – 15 June 2003, and 10 stations were sampled over a 9 hour period, using 7 different sampling techniques (Figure 12). The Talus Block Zone was visited on 15 June 2003, and 10 stations were sampled over a 7 hour period, using 6 different sampling techniques (Figure 13). The Roughtongue Reef sampling site was visited on 14 June 2003, and 29 stations were sampled over a 20 hour period, using 15 different sampling techniques (Figure 14).

Remotely Operated Vehicle

Twenty ROV dives were completed with over twenty-five hours of video collected, which included the recording of 100, two-minute transects (see Figures 9-14, for ROV stations). Two hundred and three digital images were captured. The digital images show extraordinary detail, as shown in Figures 15 & 16.

Fish/Invertebrates

Over 100 different fish species (Appendix B) were collected with eight trawl tows, four sled tows, and three longline deployments. Over 1,500 fish were sampled and 126 preserved fish specimens were archived at FISC, Gainesville as voucher specimens. Invertebrate sampling resulted in the collection of over one hundred invertebrate specimens, with 90 specimens preserved for catalogue and identification purposes. The frayed ends of the tangles was found to be highly effective at entrapping gorgonians and crustaceans (with hard pointed carapaces). The tangles was deployed six times during the cruise retrieving many whole gorgonian specimens which will be used for species identification. Overall, the invertebrate specimens collected included: crustaceans (crabs, lobsters, shrimp), molluscs (squids, scallops, snails), gorgonians (sea fans, sea whips), echinoderms (sea stars, urchins, crinoids), octocorallians (coral specimens), and polychaetes (bristle worms, tube worms). Dr. Martha Nizinski, an invertebrate taxonomist with the National Systematics Laboratory for NOAA National Marine Fisheries Service, located in the Smithsonian Institute, provided her expertise on the cruise. Collaboration with this project made available her knowledge on the biodiversity, biogeography, and community structure of deep-water, decapod crustaceans.

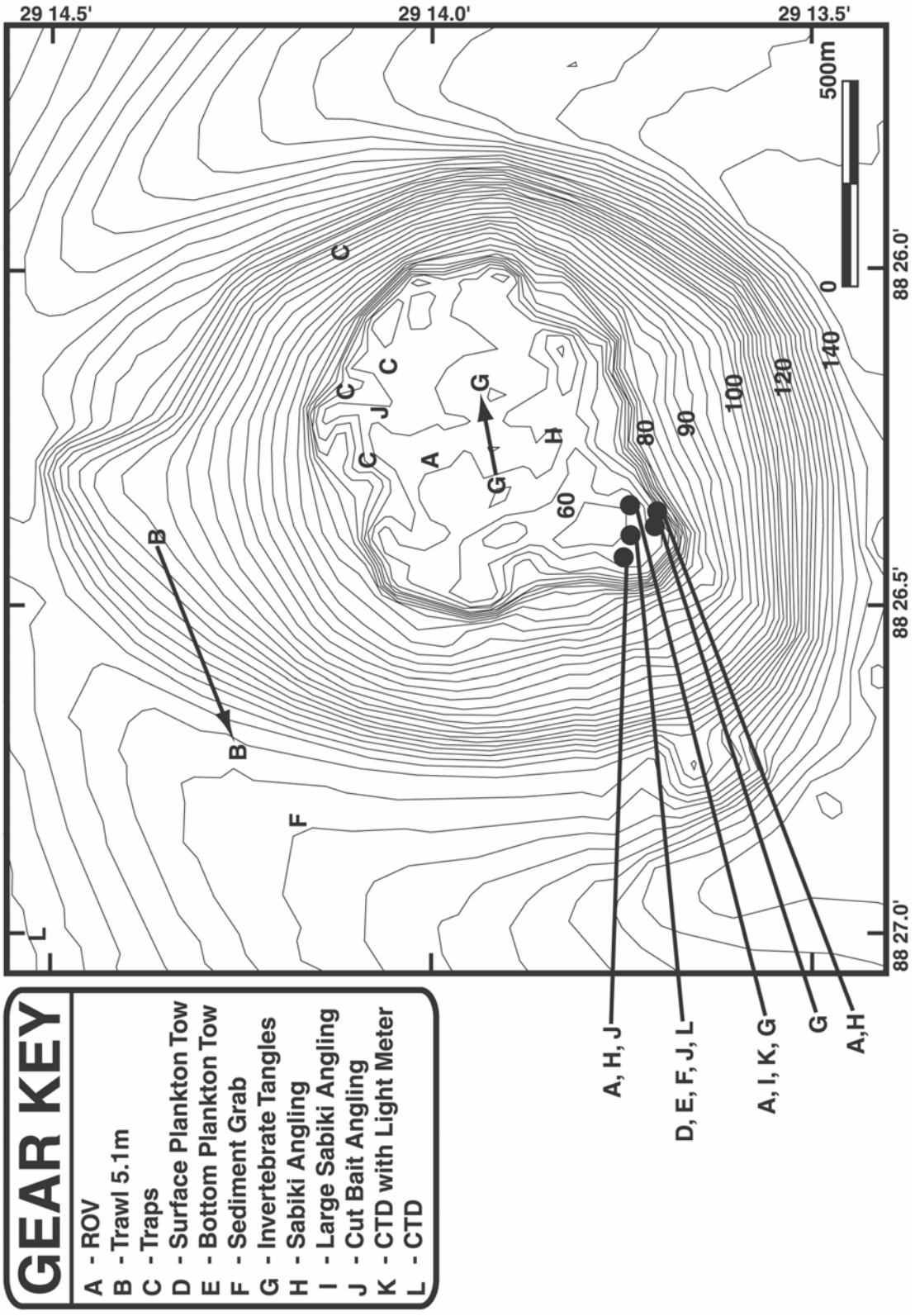

Figure 9. Stations sampled at the Mountain Top sampling site by gear type. Contour lines are in 2 meter intervals.

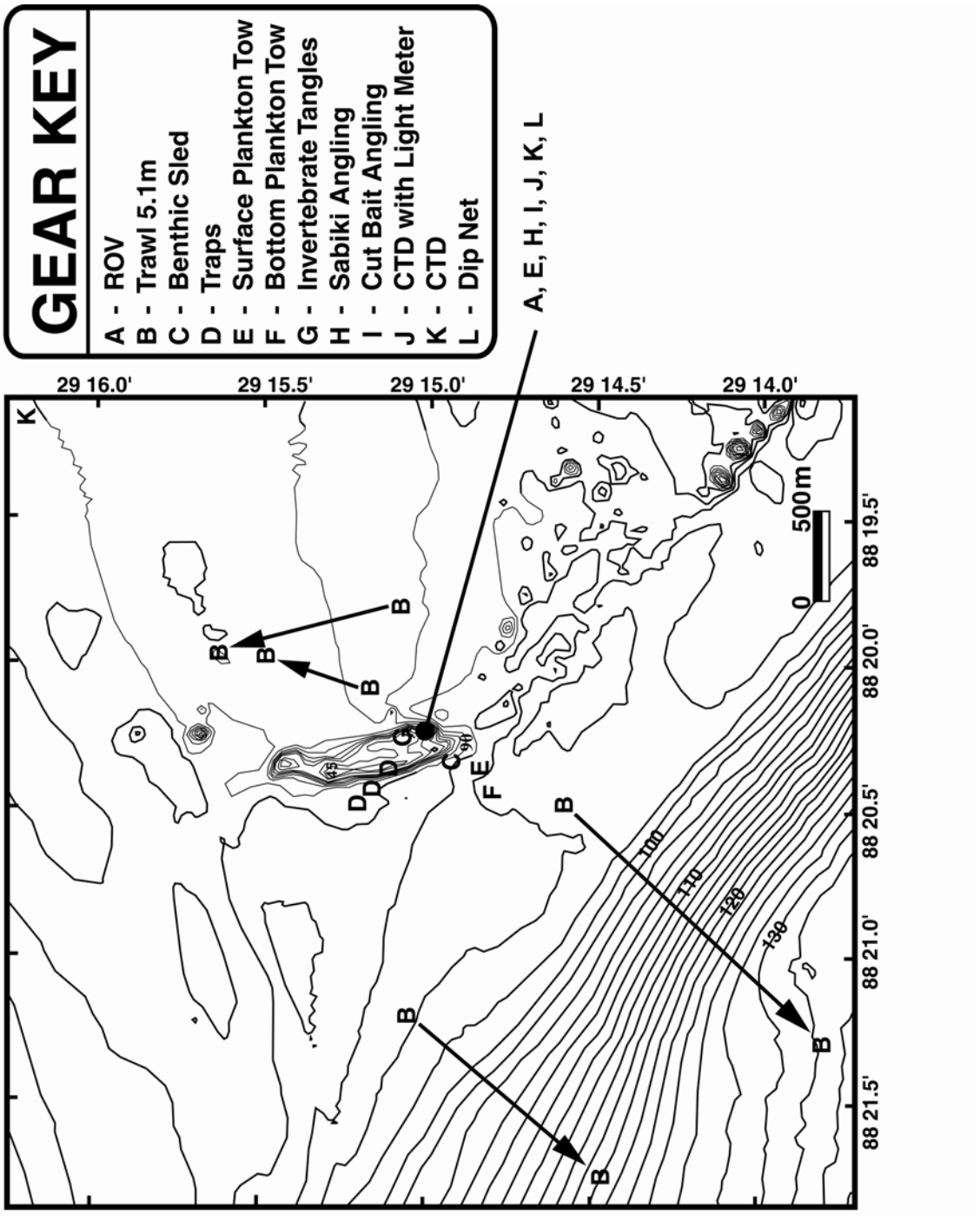

Figure 10. Stations sampled at the Alabama Alps sampling site by gear type. Contour lines are in 5 meter intervals.

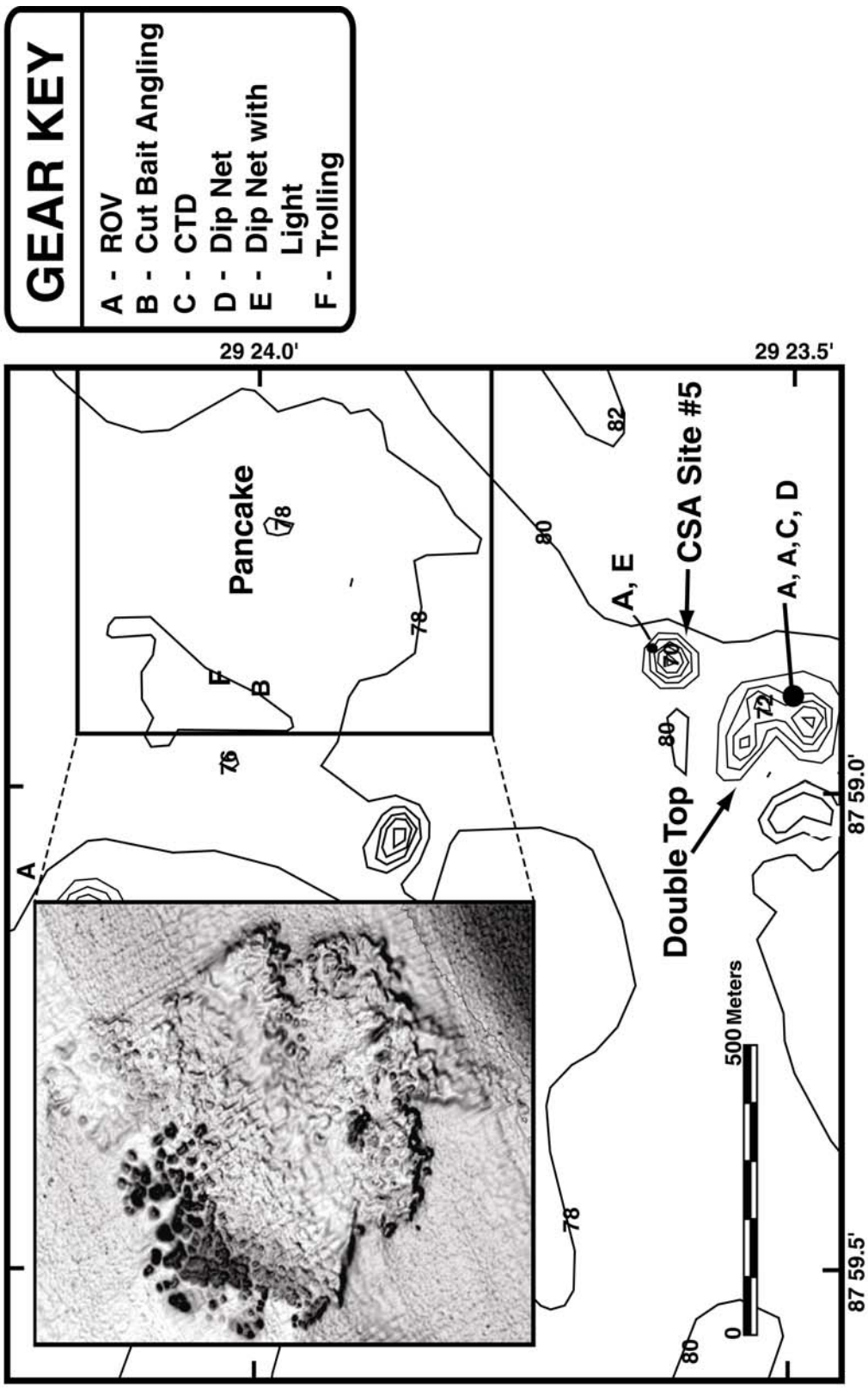

Figure 11. Stations sampled at the Double Top and Pancake Reef sampling site by gear type. Contour lines are in 2 meter intervals.

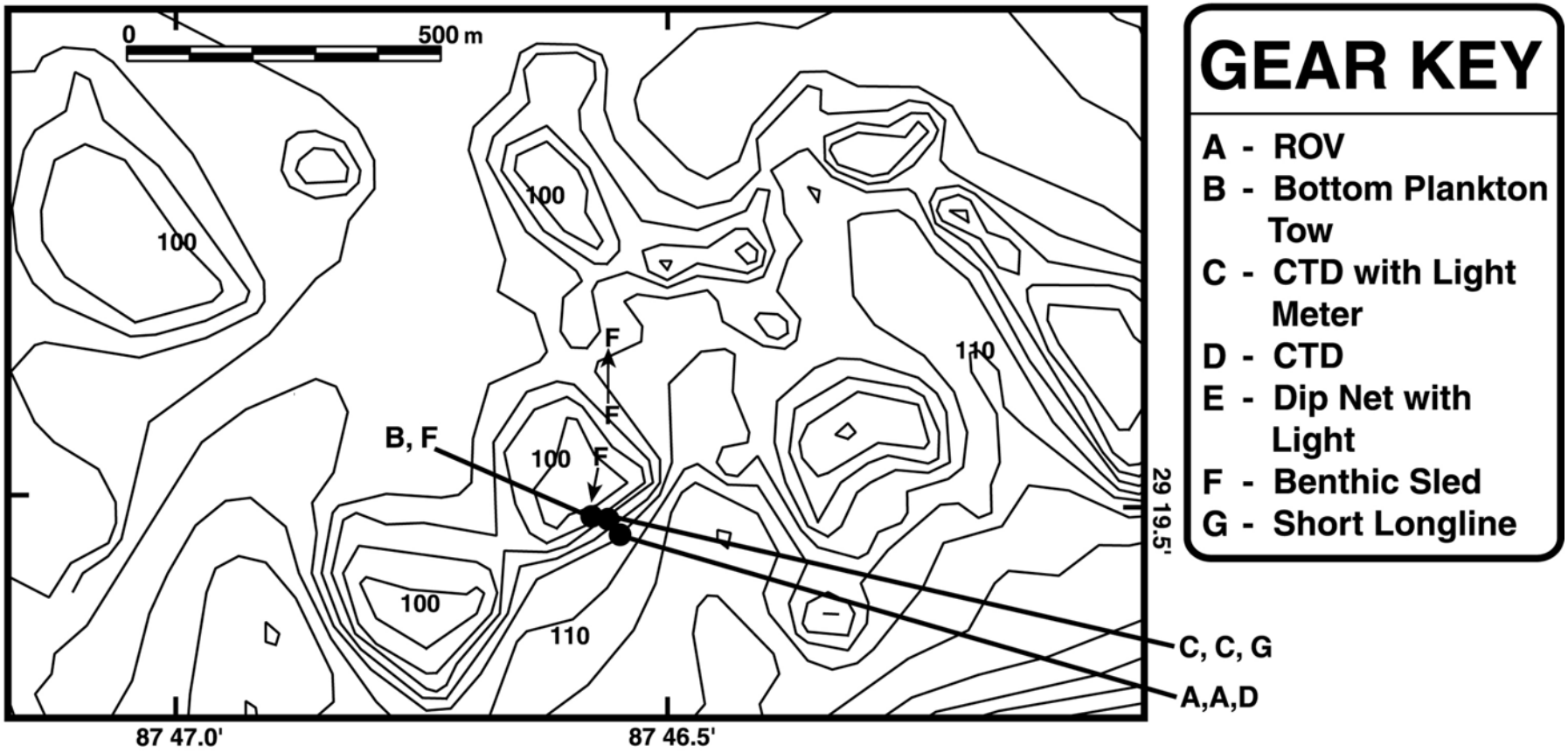

Figure 12. Stations sampled at the Ludwick & Walton sampling site by gear type. Contour lines are in 5 meter intervals.

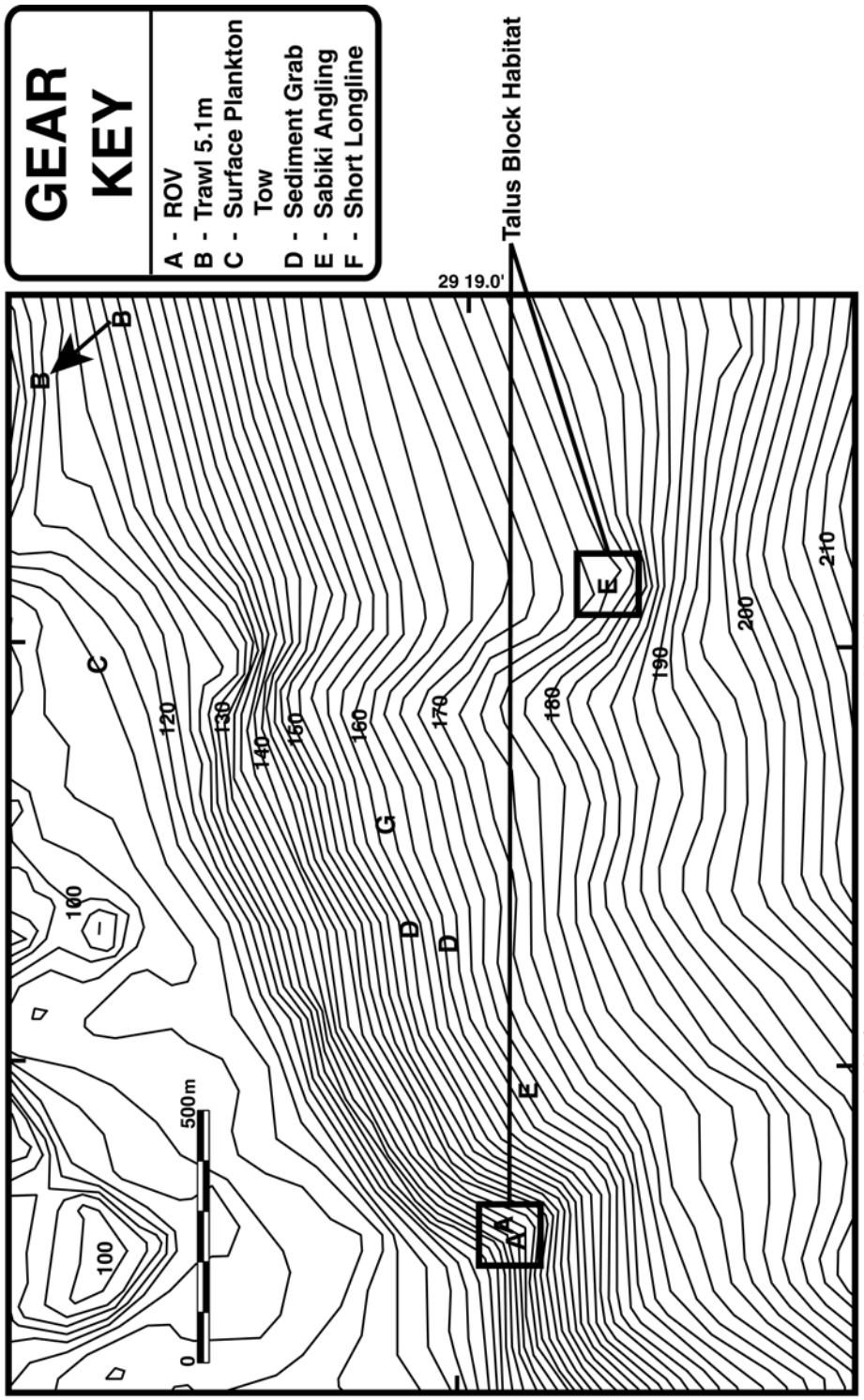

Figure 13. Stations sampled at the Foreslope Talus Blocks sampling site by gear type. Contour lines are in 5 meter interval.

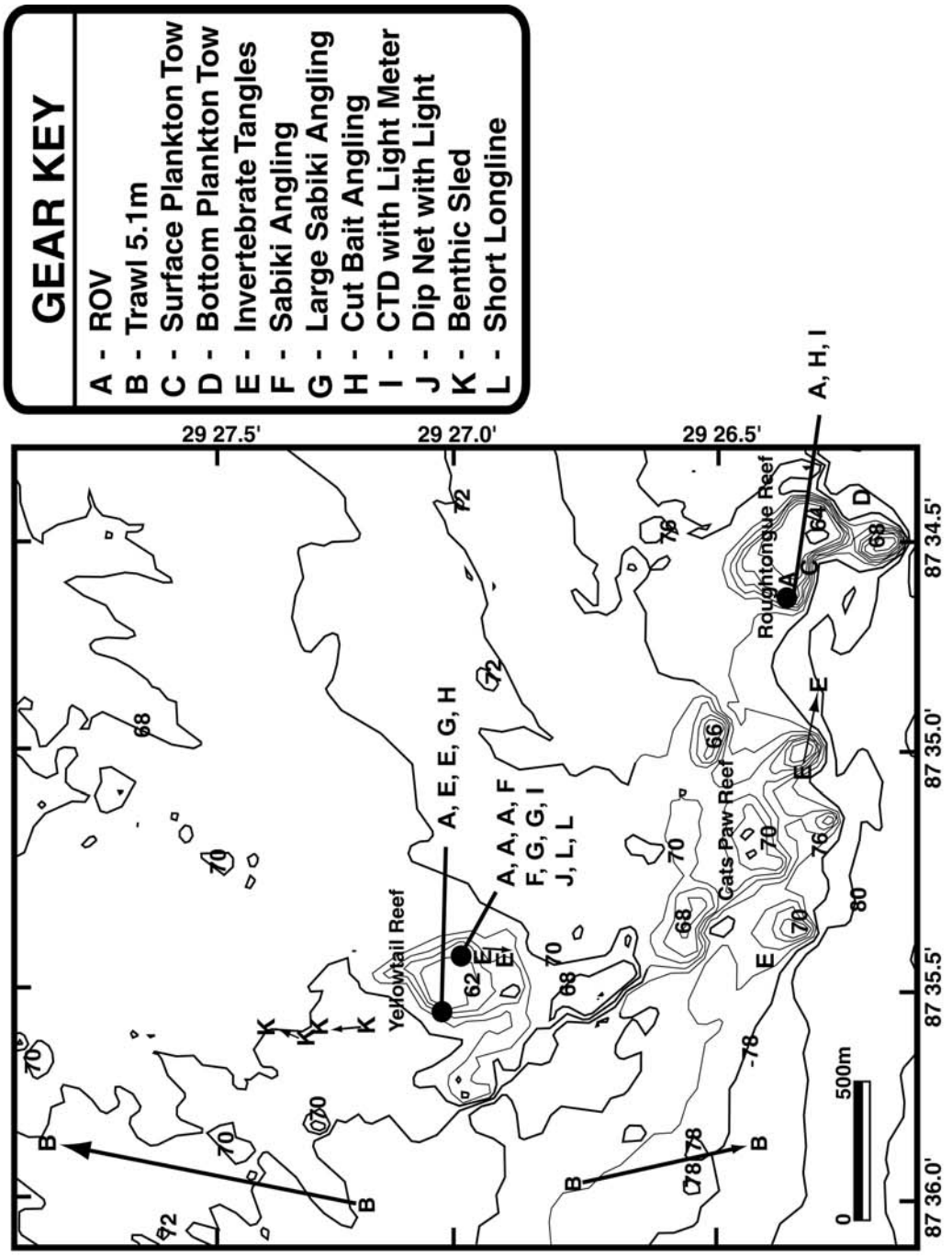

Figure 14. Stations sampled at the Roughtongue Reef sampling site by gear type. Contour lines are in 2 meter intervals.

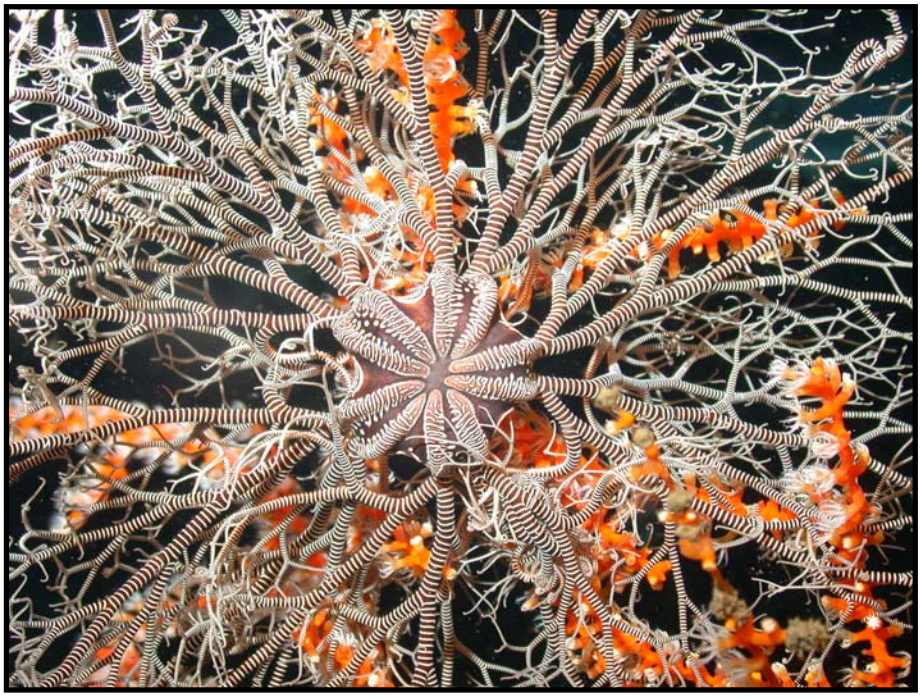

Figure 15. A close-up digital camera image of a basket star attached to a gorgonian (Station TM-2003-01-005, Depth 57 meters).

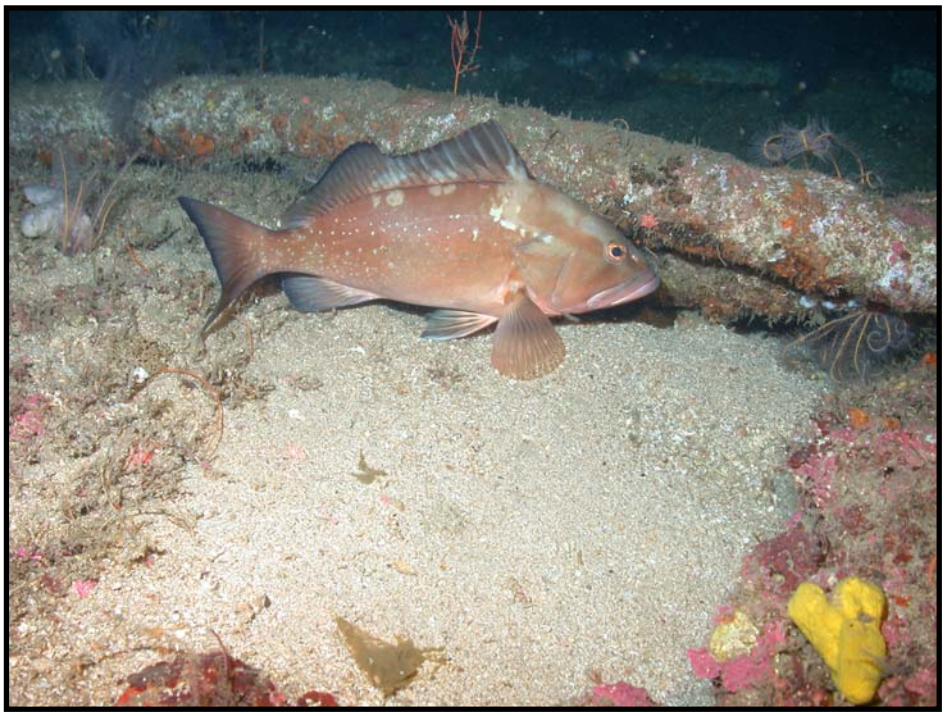

Figure 16. A wide angle digital camera image of a red grouper (*Epinephelus morio*), resting near an undersea cable or pipeline.
(Station TM-2003-01-005, Depth 57 meters).

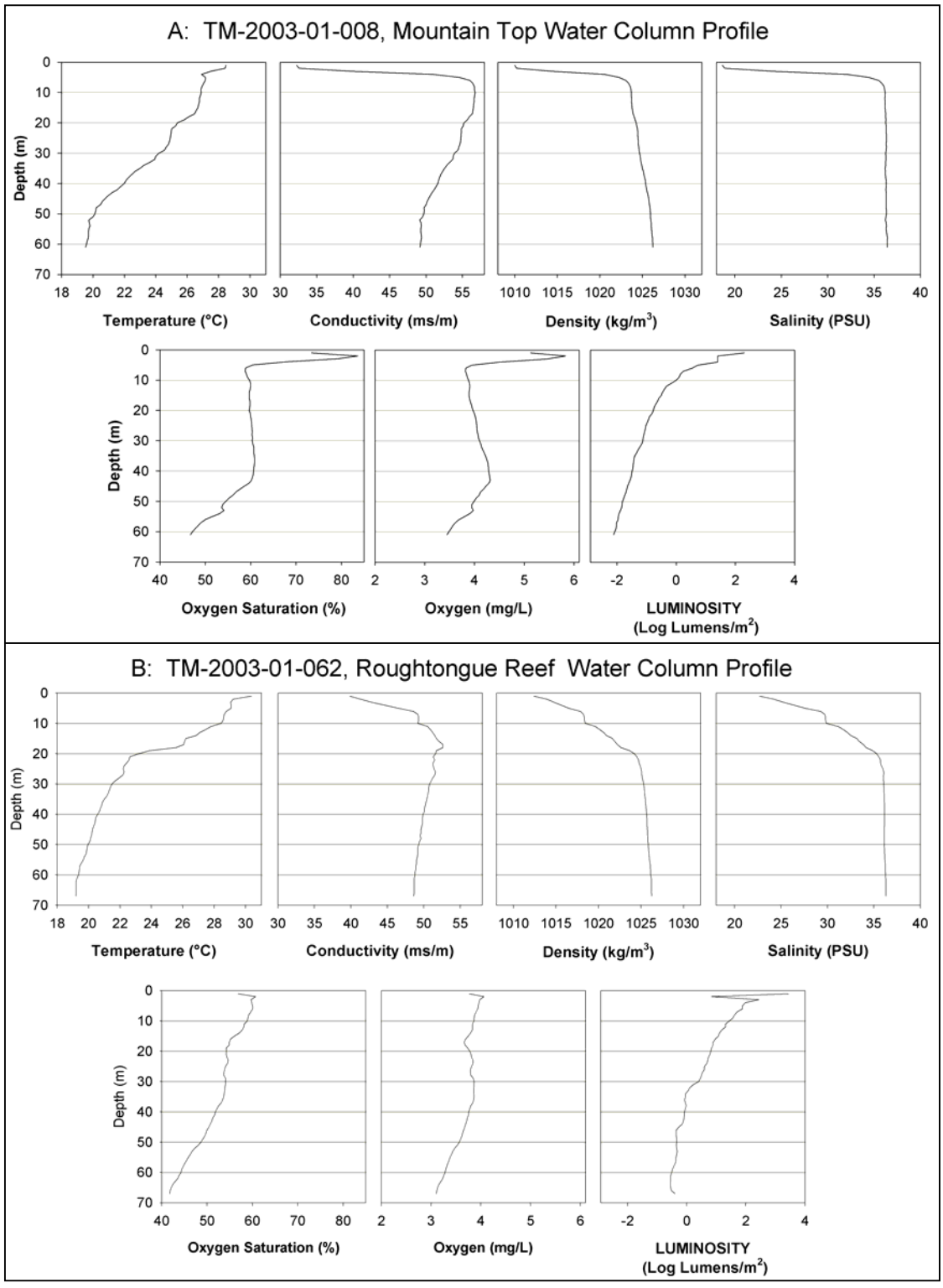

Figure 17. Seabird water-column profiles from Mountain Top (A), and Roughtongue Reef (B).

Stable Isotope Collection

One hundred and thirty-nine stable isotope samples were collected from flora and faunal sources during the cruise. The collections completed the target number of thirty samples for over seventy species. Additionally, phytoplankton (n=9), zooplankton (n=9), invertebrate (n=8), *Sargassum* (n=9), and sediment samples (n=4) were collected to determine top-down versus bottom-up signatures.

Water Chemistry and Light Data

Outflow from the Mississippi River, at the time of sampling, had a major influence on the surface water parameters (Figure 15). When comparing water parameter data from Mountain Top (closest to the mouth of the Mississippi) to that from Roughtongue Reef (farthest east of the mouth) a similar freshwater signature is found. Salinity plots display a surface water mass which is less saline and extends to nearly 8 m in depth. Below the 8 m mark, the salinity stabilizes to roughly 36 (PSU). The Mississippi River also influenced light penetration as well (Figure 15). Light measurements at Mountain Top decreased at a faster rate than those of Roughtongue Reef. By calculating the anti-log of the bottom measurements, the amount of light can be conceptualized. A light level of log -2 lumens/m^2 is roughly equivalent to the amount of light seen on a starry night, without moonlight (about 0.01 lumens).

METADATA

Remotely Operated Vehicle Operations

The ROV collected video is in two formats, with original video recorded onto 25 mini-DV tapes, and duplications created in DVD format. The digital still shots are in JPEG format and require 208 megabytes for storage. The ROV operation video, images, and analysis data are stored at the USGS-Florida Integrated Science Center, Gainesville, Florida.

Fish/Invertebrate Sampling

The master specimen log containing all catch data and preserved specimens, is located at the USGS-Florida Integrated Science Center, Gainesville, Florida.

CTD and Light Data

The master log, containing all water parameter data, is located at the USGS-Florida Integrated Science Center, Gainesville, Florida.

CONTINUING ANALYSES

Remotely Operated Vehicle Operations

Video analysis of the 100 two-minute transects, for estimation of average invertebrate and fish density (individuals per m^2), is still in the processing stage. Digital still image data, for both epifaunal percent cover and species identification, is also in the processing stage.

Fish/Invertebrate Sampling

Identification of collected invertebrate and fish species is ongoing.

Stable Isotope Collection

The stable isotope samples have been prepared for shipment (weighed, dried, and plated) to the Stable Isotope Facility at the University of California at Davis, California.

Project Itinerary

The following project itinerary has been proposed for fiscal year 2004 and outlines the anticipated date of analysis completion:

Winter 2004
- Component Ichthyoplankton synopsis study (Shultz-NMFS) and Serranid age and growth reproduction analysis study (Thurman and McBride – FMRI) reports completed, edited and published in CD-ROM format.
- Continued analysis of fish abundance and habitat use.
- Continued analysis of mega-epifaunal abundance, percent cover, and habitat distribution.
- Continued analysis of water quality parameters.
- Isotope samples sent off for laboratory analysis.
- Archival of all data onto DVD-ROM media storage.

Spring 2004
- Continued analysis of fish abundance and habitat use.
- Continued analysis of mega-epifaunal abundance, percent cover, and habitat distribution.
- Continued analysis of water quality parameters.

Summer 2004
- Fish abundance and habitat use data synthesis and interpretation.
- Epifaunal abundance and habitat distribution data synthesis and interpretation.
- Water quality data synthesis and interpretation.
- Isotopic data synthesis and interpretation.

Fall 2004
- Preparation of NEGOM fish and megafaunal invertebrate draft final report.

PRODUCTS

Our USGS team established a study plan in 2001 with eight projected products, as outlined below:

1) USGS and COLLABORATOR TEAM PROJECT FINAL REPORT. The report will coordinate results from all components to provide an integrated knowledge of community structure and function on critical OCS deep hard-bottom reef communities in the IOS-NEGOM study area.

2) USGS PI and COLLABORATOR SCIENTIFIC MANUSCRIPTS. Based on the results of the project, USGS Research Team members (under the lead of Project PIs) will prepare and submit a number of scientific manuscripts for publication in appropriate peer-reviewed journals.

3) USGS/GD HRMBS MAPS/DATABASE. The USGS/GD PI will resolve all HRMBS data into map images to be placed on the USGS/GD website, with links to USGS/BRD, MMS and NMFS. All maps, and the supporting digital database will be public information, accessible via the Internet (with maps in compressed format to facilitate transmission), or upon request if too large to access electronically. Selected images and geological interpretations will be published in scientific journals.

4) USGS PROJECT GIS/VIDEOTAPE DATABASE. All USGS fish community sampling data will be stored in a project GIS geo-referenced database maintained at FISC (Arcview). ROV videotape copies will be archived at FCSC in DVD format. Pending completion of USGS PI manuscripts, all sampling data and archived videotapes will be available to the scientific community at large.

5) USGS RESEARCH TEAM ORAL REPORTS. Over the course of the IOS-NEGOM project, USGS Research Team members will present preliminary research findings orally at scientific workshops, MMS Information Transfer Meetings, and scientific society meetings (e.g., ASIH, AFS, ESA, International Deep-Sea Symposium).

6) METADATA. Metadata for all datasets will be developed through the Spatial Metadata Management System (SMMS 3.2) and will be compliant with the FGDC and NBII standards. All USGS metadata will be submitted to the NBII and FGDC metadata clearinghouses.

7) VOUCHER MATERIAL. OCS sampling has resulted in much new material of many very poorly known reef fish species, and examples of potentially undescribed species. Representative specimens of taxonomically important material will be preserved, documented, and donated to either the U.S. National Museum of Natural History or the Florida Museum of Natural History to serve as permanent voucher material for formal description and taxonomic study.

8) GUIDES and POSTERS. As in the NEGOM-CMEP study, each species of fish sampled will be prepared and photographed at sea to provide a permanent photographic record of the OCS fish fauna. After all priority scientific products are completed, we intend to produce a color guide and color posters to aid interested investigators and the public in identifying fishes comprising the OCS fauna in the Gulf of Mexico. These products will be credited to USGS and its collaborators and cooperators, and will bear the logos of appropriate contributors.

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Appendix A

The station log information for the TM-2003-01, Western NEGOM sampling cruise. Easting and Northing UTM Coordinates are for zone 16 North.

STATION TM-2003-01-	Date / Time (CDT)	Latitude (N)	Longitude (W)	Easting (X)	Northing (Y)	DEPTH (m)	GEAR	REEF NAME
001	6/11/2003 2:28	29 14.121	88 25.993	360715	3234912	70	Trapline	Mountain Top
002	6/11/2003 2:49	29 14.056	88 26.163	360438	3234795	62	Trapline	Mountain Top
003	6/11/2003 3:06	29 14.112	88 26.202	360376	3234899	66	Trapline	Mountain Top
004	6/11/2003 3:23	29 14.082	88 26.306	360207	3234846	61	Trapline	Mountain Top
005	6/11/2003 5:13	29 13.743	88 26.445	359974	3234223	58	ROV	Mountain Top
006	6/11/2003 6:10	29 13.743	88 26.445	359974	3234223	58	Sabiki Angling	Mountain Top
007	6/11/2003 6:45	29 13.743	88 26.445	359974	3234223	57	Cut Bait Angling	Mountain Top
008	6/11/2003 7:46	29 13.731	88 26.416	360020	3234200	57	CTD with Light meter	Mountain Top
009	6/11/2003 8:13	29 13.731	88 26.416	360020	3234200	57	Cut Bait Angling	Mountain Top
010	6/11/2003 9:50	29 13.731	88 26.416	360020	3234200	57	Sediment Grab	Mountain Top
011	6/11/2003 10:00	29 13.731	88 26.414	360024	3234200	57	Surface Plankton Tow	Mountain Top
012	6/11/2003 10:06	29 13.731	88 26.413	360025	3234200	57	Bottom Plankton Tow	Mountain Top
013	6/11/2003 10:40	29 13.746	88 26.374	360089	3234227	55	Large Sabiki Angling	Mountain Top
014	6/11/2003 12:28	29 13.739	88 26.370	360095	3234214	56	ROV	Mountain Top
015	6/11/2003 14:26	29 13.735	88 26.368	360098	3234206	56	CTD with Light meter	Mountain Top
016	6/11/2003 14:51	29 13.735	88 26.368	360098	3234206	57	Invertebrate Tangler	Mountain Top
017	6/11/2003 15:40	29 13.700	88 26.374	360088	3234142	64	ROV	Mountain Top
018	6/11/2003 18:00	29 13.700	88 26.374	360088	3234142	64	Sabiki Angling	Mountain Top
019	6/11/2003 19:07	29 13.837	88 26.264	360269	3234393	61	Sabiki Angling	Mountain Top
020	6/11/2003 21:13	29 13.912	88 26.337	360153	3234533	61	Invertebrate Tangler	Mountain Top
021	6/11/2003 22:02	29 14.357	88 26.424	360022	3235356	96	Trawl 4.9 m	Mountain Top

Appendix A continued

STATION TM-2003-01-	Date / Time (CDT)	Latitude (N)	Longitude (W)	Easting (X)	Northing (Y)	DEPTH (m)	GEAR	REEF NAME
022	6/11/2003 22:29	29 14.510	88 27.021	359058	3235651	115	CTD	Mountain Top
023	6/11/2003 22:49	29 14.167	88 26.847	359332	3235014	115	Sediment Grab	Mountain Top
024	6/11/2003 23:40	29 14.067	88 26.229	360331	3234817	64	Cut Bait Angling	Mountain Top
025	6/12/2003 1:08	29 13.999	88 26.301	360213	3234693	62	ROV	Mountain Top
026	6/12/2003 9:15	29 16.218	88 19.162	371824	3238655	84	CTD	Mountain Top
027	6/12/2003 9:57	29 15.204	88 20.366	369853	3236804	68	Trapline	Mountain Top
028	6/12/2003 10:07	29 15.116	88 20.358	369864	3236642	69	Trapline	Mountain Top
029	6/12/2003 10:23	29 25.261	88 20.402	370007	3255379	78	Trapline	Mountain Top
030	6/12/2003 13:15	29 15.018	88 20.250	370036	3236459	70	Sabiki Angling	Alabama Alps
031	6/12/2003 14:15	29 15.018	88 20.250	370036	3236459	70	Sabiki Angling	Alabama Alps
032	6/12/2003 14:34	29 15.015	88 20.246	370043	3236453	73	Dip net	Alabama Alps
033	6/12/2003 14:45	29 15.015	88 20.246	370043	3236453	73	Cut Bait Angling	Alabama Alps
034	6/12/2003 15:48	29 15.000	88 20.240	370052	3236425	70	CTD	Alabama Alps
035	6/12/2003 15:55	29 15.000	88 20.240	370052	3236425	70	Dip net	Alabama Alps
036	6/12/2003 16:22	29 14.995	88 20.238	370055	3236416	70	Dip net	Alabama Alps
037	6/12/2003 17:31	29 15.055	88 21.212	368479	3236545	91	Trawl 4.9 m	Alabama Alps
038	6/12/2003 18:20	29 14.586	88 20.482	369652	3235665	92	Trawl 4.9 m	Alabama Alps
039	6/12/2003 20:04	29 14.929	88 20.332	369902	3236296	88	Benthic Sled	Alabama Alps
040	6/12/2003 21:08	29 15.085	88 19.812	370747	3236574	87	Trawl 4.9 m	Alabama Alps
041	6/12/2003 23:16	29 14.843	88 20.356	369861	3236137	90	Surface Plankton Tow	Alabama Alps
042	6/12/2003 23:25	29 14.804	88 20.438	369727	3236067	90	Bottom Plankton Tow	Alabama Alps
043	6/14/2003 2:12	29 26.985	87 35.442	442716	3257961	60	ROV	Yellow Tail
044	6/14/2003 3:15	29 27.004	87 35.428	442739	3257996	61	Dip net / Night lights	Yellow Tail

Appendix A continued.

STATION TM-2003-01-	Date / Time (CDT)	Latitude (N)	Longitude (W)	Easting (X)	Northing (Y)	DEPTH (m)	GEAR	REEF NAME
045	6/14/2003 3:20	29 27.004	87 35.429	442737	3257996	60	ROV	Yellow Tail
046	6/14/2003 4:40	29 27.004	87 35.429	442737	3257996	60	Sabiki Angling	Yellow Tail
047	6/14/2003 4:44	29 27.004	87 35.428	442739	3257996	60	ROV	Yellow Tail
048	6/14/2003 5:20	29 27.003	87 35.426	442742	3257994	60	Sabiki Angling	Yellow Tail
049	6/14/2003 6:00	29 27.004	87 35.456	442694	3257996	61	Sabiki Angling	Yellow Tail
050	6/14/2003 7:48	29 26.982	87 35.439	442721	3257955	62	CTD with Light meter	Yellow Tail
051	6/14/2003 7:50	29 26.982	87 35.439	442721	3257955	62	Sabiki Angling	Yellow Tail
052	6/14/2003 8:00	29 26.982	87 35.439	442721	3257955	62	Longline	Yellow Tail
053	6/14/2003 8:55	29 26.982	87 35.439	442721	3257955	62	Longline	Yellow Tail
054	6/14/2003 8:50	30 26.982	87 35.439	442721	3257955	62	Sabiki Angling	Yellow Tail
055	6/14/2003 10:41	29 27.180	87 36.008	441803	3258326	71	Trawl 4.9 m	Yellow Tail
056	6/14/2003 11:14	29 26.770	87 35.958	441880	3257568	74	Trawl 4.9 m	Yellow Tail
057	6/14/2003 11:52	29 26.386	87 35.461	442680	3256855	75	Invertebrate Tangler	Yellow Tail
058	6/14/2003 12:09	29 26.314	87 35.044	443353	3256719	69	Invertebrate Tangler	Cat's Paw
059	6/14/2003 13:04	29 26.349	87 34.610	444055	3256780	66	ROV	Roughtongue
060	6/14/2003 14:20	29 26.349	87 34.643	444002	3256780	64	ROV	Roughtongue
061	6/14/2003 15:10	29 26.346	87 34.646	443997	3256774	64	Cut Bait Angling	Roughtongue
062	6/14/2003 16:10	29 26.346	87 34.646	443997	3256774	64	CTD with Light meter	Roughtongue
063	6/14/2003 16:24	29 26.303	87 34.587	444092	3256695	69	Surface Plankton Tow	Roughtongue
064	6/14/2003 16:45	29 26.205	87 34.422	444358	3256512	78	Bottom Plankton Tow	Roughtongue
065	6/14/2003 17:52	29 27.034	87 35.546	442549	3258052	59	ROV	Yellow Tail
066	6/14/2003 19:20	29 27.041	87 35.573	442505	3258065	63	Sabiki Angling	Yellow Tail
067	6/14/2003 19:27	29 27.041	87 35.573	442505	3258065	64	Invertebrate Tangler	Yellow Tail

Appendix A continued.

STATION TM-2003-01-	Date / Time (CDT)	Latitude (N)	Longitude (W)	Easting (X)	Northing (Y)	DEPTH (m)	GEAR	REEF NAME
068	6/14/2003 20:00	29 27.029	87 35.568	442513	3258043	61	Cut Bait Angling	Yellow Tail
069	6/14/2003 21:03	29 26.940	87 35.466	442677	3257878	61	Invertebrate Tangler	Yellow Tail
070	6/14/2003 21:22	29 27.174	87 35.605	442454	3258311	68	Benthic Sled	Yellow Tail
071	6/14/2003 21:47	29 27.297	87 35.635	442407	3258539	69	Benthic Sled	Yellow Tail
072	6/14/2003 23:27	29 19.531	87 46.575	424630	3244301	96	CTD	Ludwick & Walton
073	6/14/2003 23:42	29 19.567	87 46.564	424648	3244367	97	Surface Plankton Tow	Talus Block Zone
074	6/14/2003 23:47	29 19.633	87 46.564	424649	3244489	102	Bottom Plankton Tow	Ludwick & Walton
075	6/15/2003 0:10	29 19.481	87 46.584	424615	3244209	99	Dip net / Night lights	Ludwick & Walton
076	6/15/2003 1:00	29 19.480	87 46.582	424618	3244207	98	ROV	Ludwick & Walton
077	6/15/2003 2:37	29 19.459	87 46.555	424662	3244168	106	Sabiki Angling	Talus Block Zone
078	6/15/2003 6:00	29 19 .477	87 46.569	424639	3244201	101	Sabiki Angling	Talus Block Zone
079	6/15/2003 7:00	29 19.479	87 46.569	424639	3244205	101	Short Longline	Talus Block Zone
080	6/15/2003 7:00	29 19.479	87 46.569	424639	3244205	107	Sabiki Angling	Talus Block Zone
081	6/15/2003 9:12	20 10.479	87 46.563	424539	3227585	102	CTD with Light meter	Ludwick & Walton
082	6/15/2003 10:00	29 19.467	87 46.555	424662	3244183	107	Longline	Ludwick & Walton
083	6/15/2003 12:21	29 19.468	87 46.554	424663	3244184	107	ROV	Ludwick & Walton
084	6/15/2003 14:38	29 18.948	87 46.727	424377	3243226	134	ROV	Talus Block Zone
085	6/15/2003 16:26	29 18.961	87 46.708	424408	3243250	133	CTD with Light meter	Ludwick & Walton
086	6/15/2003 17:46	29 18.860	87 45.907	425703	3243055	171	ROV	Talus Block Zone
087	6/15/2003 19:29	29 18.853	87 45.920	425682	3243042	174	Sediment Grab	Talus Block Zone
088	6/15/2003 20:17	29 18.934	87 46.544	424673	3243198	165	Sediment Grab	Talus Block Zone
089	6/15/2003 20:43	29 19.021	87 46.362	424969	3243357	169	Benthic Sled	Ludwick & Walton
090	6/15/2003 21:55	29 19.063	87 46.344	424998	3243434	154	Benthic Sled	Ludwick & Walton

Appendix A continued.

STATION TM-2003-01-	Date / Time (CDT)	Latitude (N)	Longitude (W)	Easting (X)	Northing (Y)	DEPTH (m)	GEAR	REEF NAME
091	6/15/2003 22:50	29 19.402	87 46.022	425524	3244057	111	Trawl 4.9 m	Talus Block Zone
092	6/16/2003 1:43	29 23.494	87 58.896	404752	3251770	66	ROV	Double Top
093	6/16/2003 3:47	29 23.494	87 58.891	404760	3251770	67	CTD	Double Top
094	6/16/2003 3:55	29 23.494	87 58.891	404760	3251770	67	ROV	Double Top
095	6/16/2003 2:00	29 23.494	87 58.891	404760	3251770	67	Dip net / Night lights	Double Top
096	6/16/2003 5:28	29 53.630	87 58.840	405314	3307425	65	ROV	Double Top
097	6/16/2003 5:50	29 23.629	87 58.837	404850	3252018	65	Dip net	CSA site #5
098	6/16/2003 6:56	29 24.000	87 58.889	404772	3252704	72	Cut Bait Angling	Pancake Reef
099	6/16/2003 9:30	29 24.028	87 58.884	451488	3252407	73	Trolling	Transit
100	6/16/2003 11:50	29 15.077	88 20.247	370043	3236567	71	Invertebrate Tangler	Alabama Alps
101	6/16/2003 12:20	29 14.975	88 19.952	370518	3236374	89	Trawl 4.9 m	Alabama Alps
102	6/16/2003 12:57	29 15.174	88 20.084	370309	3236744	90	Trawl 4.9 m	Alabama Alps
103	6/16/2003 14:07	29 14.991	88 20.201	370115	3236408	83	ROV	Alabama Alps
104	6/16/2003 15:08	29 15.000	88 20.200	370117	3236424	83	CTD with Light meter	Alabama Alps
105	6/16/2003 15:27	29 15.000	88 20.200	370117	3236424	83	Surface Plankton Tow	Alabama Alps
106	6/16/2003 16:09	29 15.115	88 20.358	369864	3236642	87	Traps Recovery	Alabama Alps
107	6/16/2003 16:28	29 15.167	88 20.428	369751	3236737	87	Traps Recovery	Alabama Alps
108	6/16/2003 16:50	29 15.210	88 20.480	369668	3236817	87	Traps Recovery	Alabama Alps
109	6/16/2003 20:05	29 24.223	87 59.085	404458	3253118	72	ROV	No Name Reef
110	6/16/2003 21:19	29 24.223	87 59.085	404458	3253118	72	ROV	No Name Reef

Appendix B

Summary of fish specimens captured during Cruise TM-2003-01, by sampling gear.

Taxon	Benthic Sled	Cut Bait Angling	Dipnet	Dipnet / Night light	ROV	Sabiki	Trap	Trawl	Total
Ablennes hians			1						1
Anchoa sp.				17				1	18
Ancylopsetta dilecta								2	2
Antennarius radiosus								3	3
Apogon pseudomaculatus								4	4
Balistes capriscus		5					1		6
Bellator militaris								10	10
Bembrops anatirostris								12	12
Bembrops sp								1	1
Bothidae		1						1	2
Brotulidae							1	1	2
Brotula barbata							1		1
Caranx crysos		3				11		1	15
Caulolatilus chrysops								2	2
Caulolatilus cyanops								2	2
Centropristis philadelphica								2	2
Chlorophthalmus agassizi								1	1
Chromis enchrysurus						6			6
Citharichthys cornutus								31	31
Citharichthys sp.								17	17
Conger sp.							3	1	4
Corniger spinosus								5	5
Cyclopsetta fimbriata								1	1
Cynoscion arenarius								1	1
Decodon puellaris								1	1
Epinephelus flavolimbatus		1							1
Epinephelus morio		7					8		15
Epinephelus niveatus		1							1
Gonioplectrus hispanus						1			1

Appendix B Continued.

Taxon	Benthic Sled	Cut Bait Angling	Dipnet	Dipnet / Night light	ROV	Sabiki	Trap	Trawl	Total
Gymnothorax hubbsi					1	1			2
Gymnothorax nigromarginatus								1	1
Gymnothorax sp.							1		1
Halichoeres bathyphilus						1			1
Halieutichthys aculeatus								143	143
Hemanthias leptus								1	1
Hemanthias vivanus						14			14
Holocentrus adscensionis						1			1
Hoplunnis macrurus								2	2
Kathetostoma albigutta								1	1
Lagodon rhomboides								29	29
Leiostomus xanthurus								35	35
Lepophidium brevibarbe								5	5
Lepophidium jeannae								5	5
Lepophidium sp.								7	7
Lophius gastrophysus								1	1
Lutjanus campechanus		14					1		15
Macrorhamphosus scolopax								1	1
Malacanthus plumieri		4							4
Maurolicus muelleri								8	8
Micropogonias undulatus								402	402
Mullus auratus								6	6
Muraena retifera							3		3
Mustelus canis		2							2
Mycteroperca bonaci		1							1
Mycteroperca phenax		12					9		21
Neomerinthe hemingwayi								3	3
Ogcocephalus corniger								9	9
Ogcocephalus declivirostris	2								2

Appendix B Continued

Taxon	Benthic Sled	Cut Bait Angling	Dipnet	Dipnet / Night light	ROV	Sabiki	Trap	Trawl	Total
Ogcocephalus nasutus								1	1
Ogcocephalus sp.								2	2
Ophichthus sp.								1	1
Opistognathus lonchurus						1			1
Opsanus pardus							3		3
Pagrus pagrus		13					2		15
Paralichthys sp.	4							1	5
Paranthias furcifer		3							3
Pareques iwamotoi								2	2
Pareques umbrosus							9	4	13
Peprilus burti								2	2
Physiculus fulvus								21	21
Physiculus sp.	2							2	4
Pontinus longispinis								1	1
Pontinus rathbuni								1	1
Pontinus sp.								2	2
Porichthys plectrodon								2	2
Prionotus paralatus								11	11
Prionotus sp.	1							1	2
Prionotus stearnsi		1						8	9
Pristigenys alta						1			1
Pristipomoides aquilonaris								41	41
Pronotogrammus martinicensis						31			31
Raja texana								1	1
Rhomboplites aurorubens		74				12	7		93
Saurida brasiliensis		6						17	23
Scomber colias						2			2
Scomberomorus maculatus		2							2
Scorpaena dispar								117	117

Appendix B Continued.

Taxon	Benthic Sled	Cut Bait Angling	Dipnet	Dipnet / Night light	ROV	Sabiki	Trap	Trawl	Total
Scorpaena sp.	1							2	3
Seriola dumerili		14							14
Seriola rivoliana		5							5
Serranus atrobranchus								15	15
Serranus notospilus		3						29	32
Serranus phoebe		7				7		2	16
Steindachneria argentea								34	34
Stenotomus caprinus								70	70
Syacium papillosum								9	9
Symphurus sp.	1							12	13
Synagrops bellus								23	23
Synodus foetens								6	6
Synodus intermedius								1	1
Trachurus lathami								3	3
Trachyscorpia cristulata								10	10
Trichiurus lepturus								6	6
Trichiurus sp.								2	2
Trichopsetta ventralis								6	6
Urophycis floridana							1	44	45
Urophycis regia								7	7
Total by Gear	11	179	1	17	1	89	50	1,278	1,626